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GERMINATING SEEDS ON CONTAMINATED SOIL

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In the present paper was studied the influence of uranium toxicity, on seed germination and root elongation of three types of seeds: alfalfa (Medicago sativa), cress (Lepidium sativum) and turf. Experiments were performed using solutions with different uranium concentrations compared to reference sample - distilled water, respectively: 6 ppm; 12ppm; 25 ppm; 50 ppm; 75 ppm and 150 ppm. The experimental results showed that germination and root elongation decreased with increasing uranium content in soil.

Keywords: Phytoremediation, contaminated soils, uranium

1. Introduction

One of the most difficult soil contaminations is the one produced by heavy metals, which have a particularly serious on the physiology of both vegetation and terrestrial ecosystem on humans and animals coming into direct or indirect contact with contaminated sites. The impact of heavy metals in the environment onto the human and animal health is aggravated by their persistence in the long term in the environment [1].

Natural uranium can pollute the atmosphere (powders) and water (as dissolved or suspended) and through atmosphere and water may contaminate soils, flora, fauna, aquatic and terrestrial environment [2].

A relative new method of remediating soils contaminated with heavy metals is phytoremediation. Phytoremediation is the use of certain plant species of wild flora and / or cultured to extraction, stabilization and / or neutralize contaminants present in soil [3]. In general, remediation technologies are classified into four categories based on their action on contaminant:

a) Extraction / Elimination: is a process that consists of the physical removal of contaminants from the site contaminated environment without requiring its separation from the host environment.
b) Separation: is a process in which the contaminant is removed from the host environment.

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c) Degradation: it is a chemical or biological process by which contaminants are neutralized or destroyed to produce fewer toxic components.
d) Immobilization: it is a process consisting in immobilizing or in underground and surface migration of the contaminant.

The main considerations in assessing phytoremediation as an alternative remedy for a site are contaminated media type, type and concentration of contaminants and the potential for that vegetation to develop in site [4, 5]. The main considerations in assessing phytoremediation as an alternative remedy for a site are contaminated media type, type and concentration of contaminants and the potential for that vegetation to develop in site [4, 5]. In his papers, Pavel [6-10] studies the effect of heavy metals Cd (II) and Cr (VI) on the process of germination and growth of *Lupidium sativium*. The analysis of experimental results demonstrated that at low concentrations up to 20 -25 mg/L the effect of germination process inhibition is lower, while at a concentration of 250-300 mg / L is observed a 50% inhibition of germination compared to control. The development of roots is affected both the analyzed metal ion and his concentration [11, 12]. The experimental results following completion of various studies by Caraiman [13-15] proved that germination rate of seeds of plants studied: rape, white mustard and spinach and root elongation decreased with increasing concentration of the pollutant and depended on the type of soil and polluting used. The lowest rate of germination to seed rape, recorded on polluted soil with Zn being 71.66% on OECD soil and sand 60% and root length decreased significantly from 50% zinc concentration.

Recent research, in 2013 Said Muhammad [16, 17] investigates the wild plant species for their phytoremediation potential of macro and trace metals (MTM). For this purpose, soil and wild plant species samples were collected along mafic and ultramafic terrain in the Jijal, Dubair, and Alpuri areas of Kohistan region, northern Pakistan. These samples were analyzed for the concentrations of MTM (Na, K, Ca, Mg, Fe, Mn, Pb, Zn, Cd, Cu, Cr, Ni, and Co). Soil showed significant contamination level, while plants had greater variability in metal uptake from the contaminated sites. Plant species such as *Selaginella jacquemontii*, *Rumex hastatus,* and *Plectranthus rugosus* showed multifold enrichment factor (EF) of Fe, Mn, Cr, Ni, and Co as compared to background area. Results revealed that these wild plant species have the ability to uptake and accumulate higher metals concentration. Therefore, these plant species may be used for phytoremediation of metals contaminated soil. However, higher MTM concentrations in the wild plant species could cause environmental hazards in the study area, as selected metals (Fe, Mn, Cr, Ni, Co, and Pb) have toxicological concerns. Chang used *Jatropha curcas* [18] (bioenergy crop plant) to assist in the removal of heavy metals from contaminated field soils. Analyses were conducted on the concentrations of the individual metals in the soil and in the plants, and their differences over the growth periods of the plants were determined. The calculation of plant biomass after 2 years yielded the total amount of each metal that was removed from the soil. In terms of the absorption of heavy metal contaminants by the roots and their transfer to aerial plant parts, Cd, Ni, and Zn exhibited the greatest ease of absorption, whereas Cu, Cr, and Pb interacted strongly with the root cells and remained in the roots of the plants. Paz-Ferreiro [19] indicated that biochar and phytoremediation techniques have the potential to be combined in the remediation on heavy metal polluted soils. Biochar can reduce the bioavailability and leach ability of heavy metals in the soil. On the other hand phytoextractors can reduce the amount of soil heavy metals in polluted areas. Groudev [20] has made laboratory experiments with soil samples from agricultural lands located in the Vromos Bay area, near the Black Sea coast, Southeastern Bulgaria, were soil was contaminated with radioactive elements: uranium, radium and thorium and toxic heavy metals: copper, cadmium and lead, as a result of mining and mineral processing of polymetallic ores. These experiments carried out with soil samples from these lands revealed that an efficient remediation of the soils was achieved by an in situ treatment method based on the activity of the indigenous soil micro flora. The treatment was connected with the dissolution of the contaminants in the upper soil horizons and their transfer into the deeply located soil horizons: mainly to the horizon, where they were immobilized as different insoluble compounds. The dissolution of contaminants was connected with the activity of both heterotrophic and chemolithotrophic aerobic microorganisms and the immobilization were due mainly to the anaerobic sulphate-reducing bacteria. The activity of these microorganisms was enhanced by suitable changes in the levels of some essential environmental factors such as water, oxygen and nutrient contents in the soil. Mojiri [21] and Chakroun [22] investigated the effectiveness of southern cattail (*Typha domingensis*) for phytoremediation of heavy metals from municipal waste leachate. Some plants were transplanted into pots containing 10 liters of mixed urban waste leachate and water (3/1 V:V) and aerated during experiments. Central composite design and response surface methodology were used in order to clarify the nature of the response surface in the experimental design and explain the optimal conditions of the independent variables. In the optimum conditions, the amount of removed Pb, Ni and Cd were 0.9725, 0.4681, and 0.3692 mg/kg, and Translocation Factor (TF) in 24, 48 and 72 h experiment were 1, 1.07, 1.00, 1.11, 1.32, 1.00, 1.5 1.20 and 1.02 for each heavy metal (Pb, Ni, and Cd) respectively. The findings show that *Typha domingensis* is an effective accumulator plant for phytoremediation of these heavy metals.

This study aimed to determine the toxicity of uranium on seed germination and root elongation of alfalfa (Medicago sativa), cress (Lepidium sativum) and turf (lawn), using solutions of different concentrations of uranium, compared to a reference sample distilled –water.

2. Experimental part

For laboratory tests were used Petri dishes with medium porosity filter paper, uranium solutions of different concentrations: 6 ppm; 12 ppm; 25 ppm; 50 ppm, 75 ppm and 150 ppm, water for blanks, and 3 types of seed alfalfa (*Medicago sativa*), cress (*Lepidium sativum*) and turf. They were purchased by order from the Central Laboratory for Quality of Seeds and Propagating Material in Bucharest. Petri dishes are made of glass and have a diameter of 7.7 cm.

Medium-porosity filter paper used as a support for the germination of seeds has been fixed on the Petri dishes. On the filter paper were placed six plant seeds at a distance of about one cm each. There were made two sets of three blanks, for the 3 types of seeds. In the control sample (6 samples) after the arrangement of the seed, the filter papers were saturated with 3 ml of distilled water.

After the closing of the transparent cover plates, they are horizontally arranged in the climate chamber type LGC 5101 Daihan Labtech and incubated in the dark at a temperature of 25 ± 1 ° C for 7 days. For germination experiments in solutions with different contents of uranium has a similar approach. There have been two sets of each type of seeds. Germination conditions were the same for all the experiments.

Fig.1. Preparation of the experimental samples

3. Results and discussions

After seven days of exposure in Petri plates, it was observed the pollutant effect on seed germination and root elongation control samples and experimental samples. In the blanks - the plant roots have grown and the elongation was 5-80 mm, with a growth rate higher than experimental samples. Therefore, it can be concluded - with how the contaminant concentration is greater the more inhibited the plant growth.

Fig.2. Seed germination of cress in the control sample

Experimental results after germination of seeds led to different values of the length of roots for the three types of seeds at different values of uranium solutions. The experimental results are represented in Fig. 3.

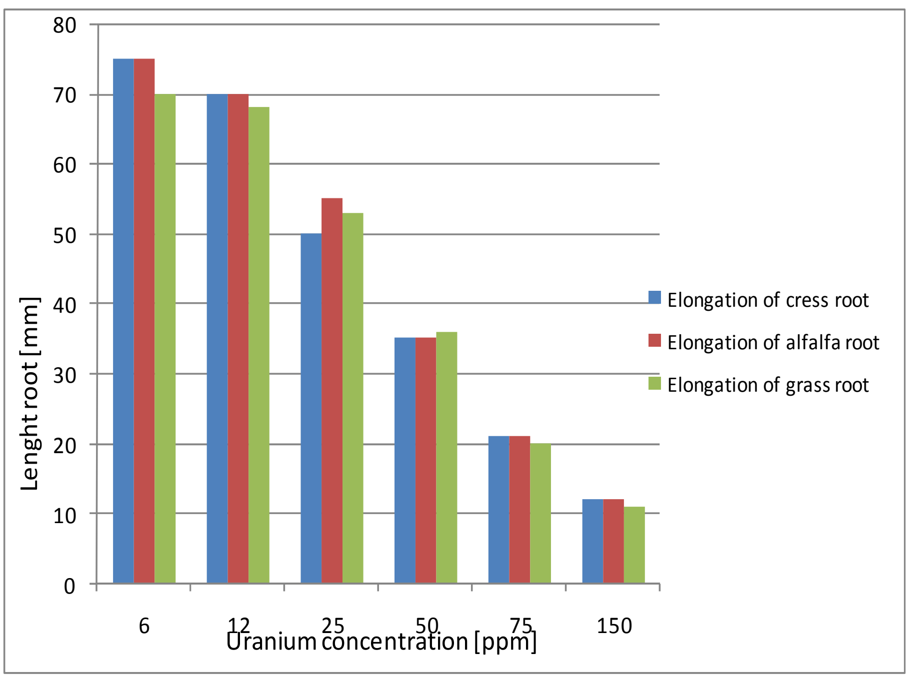

Fig.3. Comparison of the three types of seed roots

It can be seen that the length of roots decreases with increasing concentration of pollutant. Cress root has a maximum of 75 mm at 6 ppm uranium solution and an increase in strain of approximately 70 mm. The length root of alfalfa seeds is 70 mm in solution with uranium content of 6ppm, and 11 mm in 150 ppm solution. The seeds of the turf being most affected by concentration of the uranium have root elongation of 9 cm at a concentration of 150 ppm and maximum growth of 60 cm to 6 ppm concentration. Since cress seeds were the most representative is shown in Fig. 4 addiction germination time for the solution containing the uranium minimum of 6 ppm compared to the control sample.

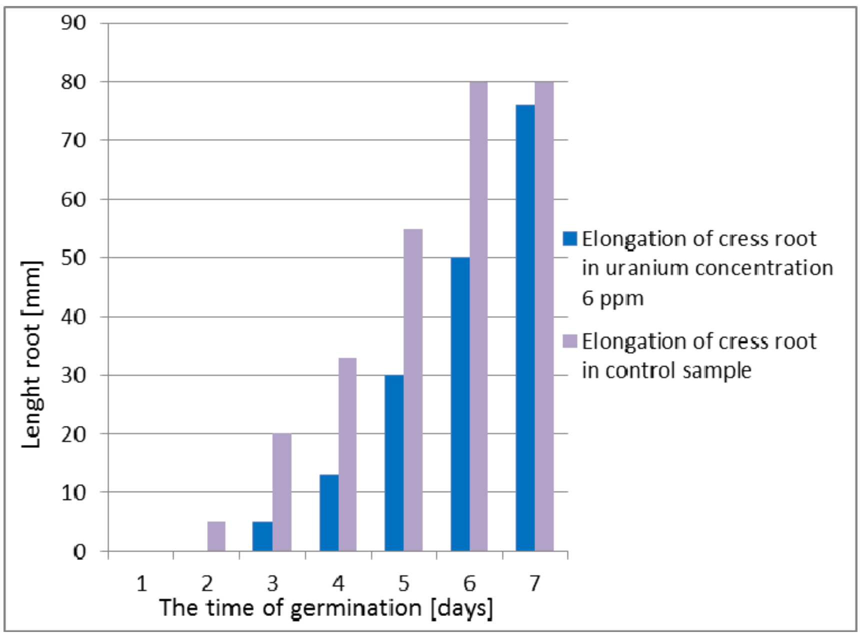

Fig.4. The time of the germinations of cress root in uranium solution 6 ppm vs. in control sample

Cress seeds from control sample have a germination rate higher than in samples. The root of the blank is visible the next day and in the experiment sample from third day. Value of cress seed root elongation of 75 mm in the 7th day.

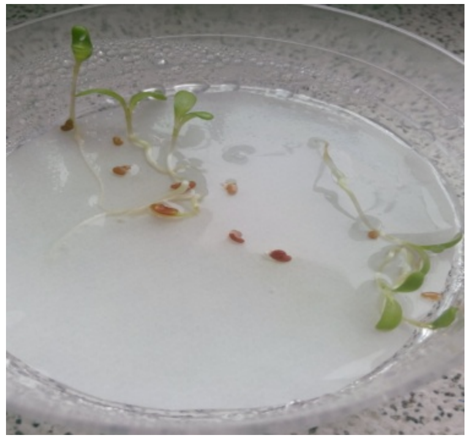

Fig.5. Elongation cress seed at concentration 6 ppm

The germination time of cress seeds in solutions with uranium content of 150 ppm are shown in Fig. 6.

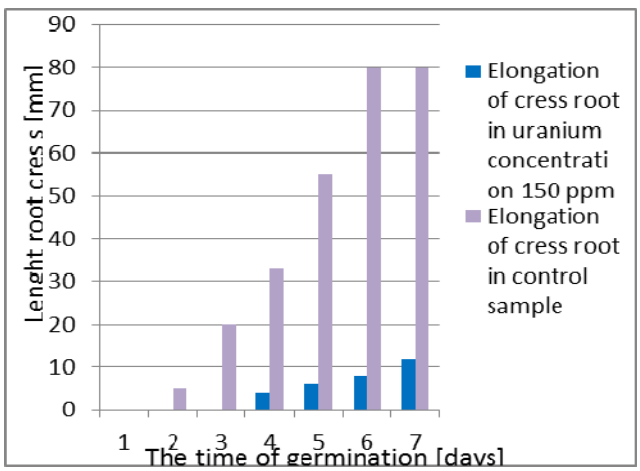

Fig.6. The time of the germinations of cress root in uranium solution 150 ppm vs. in control sample

If cress seeds contaminated with 150 ppm uranium solutions, germination was late, taking place in the fourth day of contact, compared to the control sample which have germinated since the second day, with root elongation of 5 mm.

The growth rate of roots and stems largest is 15% is reached in the seventh day compared to 13% in the fourth day.

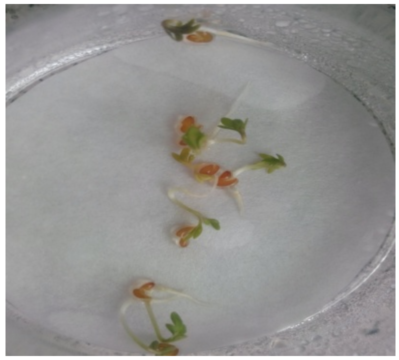

Fig.7. Elongation cress seed at concentration 150ppm

4. Conclusions

In this paper the maximum dose of uranium which not causing a negative effect on plants was determined by measuring the decrease or absence of germination and root growth, after several days of seed exposure to contaminated solutions, compared to an uncontaminated solution.

Experimental results after germination of seeds of alfalfa (Medicago sativa), cress (Lepidium sativum) and turf, showed that germination and root elongation decreased with the presence and increased concentration of contaminant solution - solutions with different contents of uranium 6 ppm; 12ppm; 25 ppm; 50 ppm, 75 ppm and 150 ppm.

The time of germination of the seeds in the control samples is shorter than in the case of experimental samples.

The roots of cress seeds have a maximum of 75 mm to 6 ppm uranium solution, a rise of about 70 mm and strain rate increased the greatest. The rate of increase in the seventh day is 94%.

The highest concentration of 150 ppm uranium, increase the speed of cress seeds smallest is 13%, with a maximum of 15% in the seventh day.

Grass seeds are most affected by the concentration of the uranium, the roots have grown lowest.

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